



Relion® Protection and Control

# 650 series DNP3 Communication Protocol Manual





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## Section 1      Introduction

### 1.1              This manual

The communication protocol manual describes a communication protocol supported by the IED. The manual concentrates on vendor-specific implementations.

### 1.2              Intended audience

This manual addresses the communication system engineer or system integrator responsible for pre-engineering and engineering for communication setup in a substation from an IED perspective.

The system engineer or system integrator must have a basic knowledge of communication in protection and control systems and thorough knowledge of the specific communication protocol.

## 1.3 Product documentation

### 1.3.1 Product documentation set

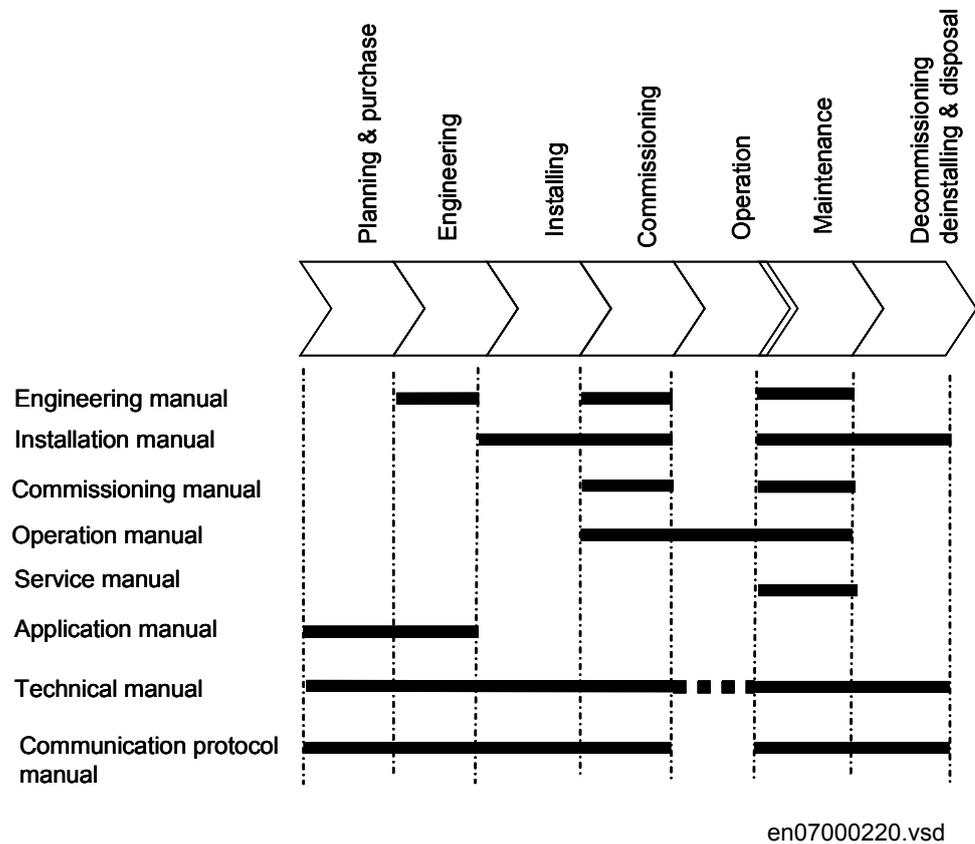


Figure 1: The intended use of manuals in different lifecycles

The engineering manual contains instructions on how to engineer the IEDs using the different tools in PCM600. The manual provides instructions on how to set up a PCM600 project and insert IEDs to the project structure. The manual also recommends a sequence for engineering of protection and control functions, LHMI functions as well as communication engineering for IEC 60870-5-103, IEC 61850 and DNP3.

The installation manual contains instructions on how to install the IED. The manual provides procedures for mechanical and electrical installation. The chapters are organized in chronological order in which the IED should be installed.

The commissioning manual contains instructions on how to commission the IED. The manual can also be used by system engineers and maintenance personnel for assistance during the testing phase. The manual provides procedures for checking of external circuitry and energizing the IED, parameter setting and configuration as

well as verifying settings by secondary injection. The manual describes the process of testing an IED in a substation which is not in service. The chapters are organized in chronological order in which the IED should be commissioned.

The operation manual contains instructions on how to operate the IED once it has been commissioned. The manual provides instructions for monitoring, controlling and setting the IED. The manual also describes how to identify disturbances and how to view calculated and measured power grid data to determine the cause of a fault.

The service manual contains instructions on how to service and maintain the IED. The manual also provides procedures for de-energizing, de-commissioning and disposal of the IED.

The application manual contains application descriptions and setting guidelines sorted per function. The manual can be used to find out when and for what purpose a typical protection function can be used. The manual can also be used when calculating settings.

The technical manual contains application and functionality descriptions and lists function blocks, logic diagrams, input and output signals, setting parameters and technical data sorted per function. The manual can be used as a technical reference during the engineering phase, installation and commissioning phase, and during normal service.

The communication protocol manual describes a communication protocol supported by the IED. The manual concentrates on vendor-specific implementations.

The point list manual describes the outlook and properties of the data points specific to the IED. The manual should be used in conjunction with the corresponding communication protocol manual.

## 1.3.2 Document revision history

Document revision/date	History
-/June 2012	First release

## 1.3.3 Related documents

Documents related to REB650	Identity number
Application manual	1MRK 505 276-UEN
Technical manual	1MRK 505 277-UEN
Commissioning manual	1MRK 505 278-UEN
Product Guide, configured	1MRK 505 279-BEN
Type test certificate	1MRK 505 279-TEN
Application notes for Circuit Breaker Control	1MRG006806

<b>Documents related to REL650</b>	<b>Identity number</b>
Application manual	1MRK 506 329-UEN
Technical manual	1MRK 506 330-UEN
Commissioning manual	1MRK 506 331-UEN
Product Guide, configured	1MRK 506 332-BEN
Type test certificate	1MRK 506 332-TEN
Application notes for Circuit Breaker Control	1MRG006806
<b>Documents related to RET650</b>	<b>Identity number</b>
Application manual	1MRK 504 128-UEN
Technical manual	1MRK 504 129-UEN
Commissioning manual	1MRK 504 130-UEN
Product Guide, configured	1MRK 504 131-BEN
Type test certificate	1MRK 504 131-TEN
Application notes for Circuit Breaker Control	1MRG006806
<b>Documents related to REC650</b>	<b>Identity number</b>
Application manual	1MRK 511 262-UEN
Technical manual	1MRK 511 263-UEN
Commissioning manual	1MRK 511 264-UEN
Product Guide	1MRK 511 265-BEN
Type test certificate	1MRK 511 265-TEN
<b>Documents related to REG650</b>	<b>Identity number</b>
Application manual	1MRK 502 042-UEN
Technical manual	1MRK 502 043-UEN
Commissioning manual	1MRK 502 044-UEN
Product Guide	1MRK 502 045-BEN
Type test certificate	1MRK 502 045-TEN
Rotor Earth Fault Protection with Injection Unit RXTTE4 and REG670	1MRG001910
Application notes for Circuit Breaker Control	1MRG006806
<b>Documents related to REQ650</b>	<b>Identity number</b>
Application manual	1MRK 505 280-UEN
Technical manual	1MRK 505 281-UEN
Commissioning manual	1MRK 505 282-UEN
Product Guide	1MRK 505 283-BEN
Type test certificate	1MRK 505 283-TEN
Application notes for Circuit Breaker Control	1MRG006806
<b>650 series manuals</b>	<b>Identity number</b>
Communication protocol manual, DNP3	1MRK 511 257-UEN
Communication protocol manual, IEC 61850-8-1	1MRK 511 258-UEN
Communication protocol manual, IEC 60870-5-103	1MRK 511 259-UEN
Cyber Security deployment guidelines	1MRK 511 268-UEN
Point list manual, DNP3	1MRK 511 260-UEN

Table continues on next page

650 series manuals	Identity number
Engineering manual	1MRK 511 261-UEN
Operation manual	1MRK 500 095-UEN
Installation manual	1MRK 514 015-UEN

## 1.4 Symbols and conventions

### 1.4.1 Symbols



The caution icon indicates important information or warning related to the concept discussed in the text. It might indicate the presence of a hazard which could result in corruption of software or damage to equipment or property.



The information icon alerts the reader of important facts and conditions.



The tip icon indicates advice on, for example, how to design your project or how to use a certain function.

Although warning hazards are related to personal injury, it is necessary to understand that under certain operational conditions, operation of damaged equipment may result in degraded process performance leading to personal injury or death. Therefore, comply fully with all warning and caution notices.

### 1.4.2 Document conventions

A particular convention may not be used in this manual.

- Abbreviations and acronyms in this manual are spelled out in the glossary. The glossary also contains definitions of important terms.
- Push button navigation in the LHMI menu structure is presented by using the push button icons.  
To navigate between the options, use  and .
- HMI menu paths are presented in bold.  
Select **Main menu/Settings**.
- LHMI messages are shown in Courier font.  
To save the changes in non-volatile memory, select Yes and press .
- Parameter names are shown in italics.

- The function can be enabled and disabled with the *Operation* setting.
- The ^ character in front of an input or output signal name in the function block symbol given for a function, indicates that the user can set an own signal name in PCM600.
- The \* character after an input or output signal name in the function block symbol given for a function, indicates that the signal must be connected to another function block in the application configuration to achieve a valid application configuration.

### 1.4.3 Functions included in 650 series IEDs

**Table 1: Main protection functions**

IEC 61850 / Function block name	ANSI	Function description
<b>Differential protection</b>		
T2WPDIF	87T	Transformer differential protection, two winding
T3WPDIF	87T	Transformer differential protection, three winding
REFPDIF	87N	Restricted earth fault protection, low impedance
HZPDIF	87	1Ph High impedance differential protection
GENPDIF	87G	Generator differential protection
<b>Impedance protection</b>		
ZQMPDIS	21	Five-zone distance protection, Quadrilateral and Mho characteristic
FDPSPDIS	21	Phase selection with load encroachment, quadrilateral characteristic
FMPSPDIS	21	Faulty phase identification with load encroachment for mho
ZDARDIR	21	Additional distance protection directional function for earth faults
ZDNRDIR	21	Directional impedance quadrilateral and mho
PPLPHIZ		Phase preference logic
ZMRPSB	68	Power swing detection
ZCVPSOF		Automatic switch onto fault logic, voltage-and current-based
ZGCPDIS	21G	Underimpedance protection for generators and transformers
LEXPDIS	40	Loss of excitation
OOSPPAM	78	Out-of-step protection
LEPDIS		Load encroachment

**Table 2: Backup protection functions**

IEC 61850 / Function block name	ANSI	Function description
<b>Current protection</b>		
PHPIOC	50	Instantaneous phase overcurrent protection
SPTPIOC	50	Instantaneous phase overcurrent protection
Table continues on next page		

IEC 61850 / Function block name	ANSI	Function description
OC4PTOC	51/67	Four-step phase overcurrent protection
OC4SPTOC	51/67	Four-step phase overcurrent protection
EFPIOC	50N	Instantaneous residual overcurrent protection
EF4PTOC	51N/67N	Four-step directional residual overcurrent protection
SDEPSDE	67N	Sensitive directional residual overcurrent and power protection
UC2PTUC	37	Time-delayed two-step undercurrent protection
LCPTTR	26	Thermal overload protection, one time constant, Celsius
LFPTTR	26	Thermal overload protection, one time constant, Fahrenheit
TRPTTR	49	Thermal overload protection, two time constants
CCBRBF	50BF	Breaker failure protection
CSPRBRF	50BF	Breaker failure protection
STBPTOC	50STB	Stub protection
CCRPLD	52PD	Pole discordance protection
BRCPTOC	46	Broken conductor check
GUPPDUP	37	Directional underpower protection
GOPPDOP	32	Directional overpower protection
DNSPTOC	46	Negative sequence-based overcurrent function
AEGGAPC	50AE	Accidental energizing protection for synchronous generator
NS2PTOC	46I2	Negative-sequence time overcurrent protection for machines
VR2PVOC	51V	Voltage-restrained time overcurrent protection
<b>Voltage protection</b>		
UV2PTUV	27	Two-step undervoltage protection
OV2PTOV	59	Two-step overvoltage protection
ROV2PTOV	59N	Two-step residual overvoltage protection
OEXPVPH	24	Overexcitation protection
LOVPTUV	27	Loss-of-voltage check
STEFPHIZ	59THD	100% Stator earth fault protection, 3rd harmonic based
<b>Frequency protection</b>		
SAPTUF	81	Underfrequency function
SAPTOF	81	Overfrequency function
SAPFRC	81	Rate-of-change frequency protection

**Table 3: Control and monitoring functions**

IEC 61850 / Function block name	ANSI	Function description
<b>Control</b>		
SESRSYN	25	Synchrocheck, energizing check and synchronizing
SMBRREC	79	Autorecloser
STBRREC	79	Autorecloser
SCILO	3	Logical node for interlocking
BB_ES	3	Interlocking for busbar earthing switch
A1A2_BS	3	Interlocking for bus-section breaker
A1A2_DC	3	Interlocking for bus-section disconnecter
ABC_BC	3	Interlocking for bus-coupler bay
BH_CONN	3	Interlocking for 1 1/2 breaker diameter
BH_LINE_A	3	Interlocking for 1 1/2 breaker diameter
BH_LINE_B	3	Interlocking for 1 1/2 breaker diameter
DB_BUS_A	3	Interlocking for double CB bay
DB_BUS_B	3	Interlocking for double CB bay
DB_LINE	3	Interlocking for double CB bay
ABC_LINE	3	Interlocking for line bay
AB_TRAFO	3	Interlocking for transformer bay
SCSWI		Switch controller
SXCBR		Circuit breaker
SXSWI		Circuit switch
POS_EVAL		Evaluation of position indication
SELGGIO		Select release
QCBAY		Bay control
LOCREM		Handling of LR-switch positions
LOCREMCTRL		LHMI control of PSTO
TR8ATCC	90	Automatic voltage control for tap changer, parallel control
TCMYLTC	84	Tap changer control and supervision, 6 binary inputs
SLGGIO		Logic-rotating Switch for function selection and LHMI presentation
VSGGIO		Selector mini switch extension
DPGGIO		IEC61850 generic communication I/O functions double point
SPC8GGIO		Single-point generic control 8 signals
AUTOBITS		AutomationBits, command function for DNP3.0
I103CMD		Function commands for IEC60870-5-103
I103IEDCMD		IED commands for IEC60870-5-103
I103USRCMD		Function commands user defined for IEC60870-5-103
I103GENCMD		Function commands generic for IEC60870-5-103
I103POSCMD		IED commands with position and select for IEC60870-5-103
Table continues on next page		

IEC 61850 / Function block name	ANSI	Function description
<b>Secondary system supervision</b>		
CCSRDIF	87	Current circuit supervision
SDDRFUF		Fuse failure supervision
TCSSCBR		Breaker close/trip circuit monitoring
<b>Logic</b>		
SMPPTRC	94	Tripping logic
SPTPTRC	94	Tripping logic
TMAGGIO		Trip matrix logic
OR		Configurable logic blocks, OR
INVERTER		Configurable logic blocks, Inverter
PULSETIMER		Configurable logic blocks, PULSETIMER
GATE		Configurable logic blocks, Controllable gate
XOR		Configurable logic blocks, exclusive OR
LOOPDELAY		Configurable logic blocks, loop delay
TimerSet		Configurable logic blocks, timer
AND		Configurable logic blocks, AND
SRMEMORY		Configurable logic blocks, set-reset memory
RSMEMORY		Configurable logic blocks, reset-set memory
FXDSIGN		Fixed-signal function block
B16I		Boolean 16 to Integer conversion
B16FCVI		Boolean 16 to Integer conversion with logic node representation
IB16A		Integer to Boolean 16 conversion
IB16FCVB		Integer to boolean 16 conversion with logic node representation
<b>Monitoring</b>		
CVMMXN		Measurements
CMMXU		Phase current measurement
VMMXU		Phase-phase voltage measurement
CMSQI		Current sequence component measurement
VMSQI		Voltage sequence measurement
VNMMXU		Phase-neutral voltage measurement
AISVBAS		Function block for service values presentation of the analog inputs
TM_P_P2		Function block for service value presentation of primary analog inputs 600TRM
AM_P_P4		Function block for service value presentation of primary analog inputs 600AIM
TM_S_P2		Function block for service value presentation of secondary analog inputs 600TRM
AM_S_P4		Function block for service value presentation of secondary analog inputs 600AIM
CNTGGIO		Event counter
DRPRDRE		Disturbance report
AxRADR		Analog input signals
Table continues on next page		

IEC 61850 / Function block name	ANSI	Function description
BxRBDR		Binary input signals
SPGGIO		IEC61850 generic communication I/O functions
SP16GGIO		IEC61850 generic communication I/O functions 16 inputs
MVGGIO		IEC61850 generic communication I/O functions
MVEXP		Measured value expander block
LMBRFLO		Fault locator
SPVNZBAT		Station battery supervision
SSIMG	63	Insulation gas-monitoring function
SSIML	71	Insulation liquid-monitoring function
SSCBR		Circuit breaker condition monitoring
I103MEAS		Measurands for IEC60870-5-103
I103MEASUSR		Measurands user defined signals for IEC60870-5-103
I103AR		Function status auto-recloser for IEC60870-5-103
I103EF		Function status earth-fault for IEC60870-5-103
I103FLTPROT		Function status fault protection for IEC60870-5-103
I103IED		IED status for IEC60870-5-103
I103SUPERV		Supervision status for IEC60870-5-103
I103USRDEF		Status for user defiend signals for IEC60870-5-103
<b>Metering</b>		
PCGGIO		Pulse counter logic
ETPMTR		Function for energy calculation and demand handling

**Table 4:** *Designed to communicate*

IEC 61850 / Function block name	ANSI	Function description
<b>Station communication</b>		
IEC61850-8-1		IEC61850 communication protocol
DNPSE DNPGEN RS485DNP DNPFC CH1TCP - CH4TCP OPTICALDNP MSTSERIAL MST1TCP - MST4TCP RS485GEN OPTICALPROT RS485PROT		DNP3.0 for serial communication EIA485 DNP3.0 for TCP/IP communication protocol DNP3.0 for EIA-485 communication protocol DNP3.0 fault records for TCP/IP communication protocol DNP3.0 for TCP/IP communication protocol DNP3.0 for TCP/IP communication protocol DNP3.0 for TCP/IP communication protocol DNP3.0 for optical RS-232 communication protocol DNP3.0 for serial communication protocol RS485 Operation selection for optical serial Operation selection for RS485
DNPFC		DNP3.0 fault records for TCP/IP communication protocol
OPTICAL103		IEC60870-5-103 Optical serial communication
RS485103		IEC60870-5-103 serial communication for RS485
GOOSEINTLKRCV		Horizontal communication via GOOSE for interlocking
Table continues on next page		

IEC 61850 / Function block name	ANSI	Function description
GOOSEBINRCV		GOOSE binary receive
GOOSEVCTRCONF		GOOSE VCTR configuration for send and receive
VCTRSEND		Voltage control sending block for GOOSE
GOOSEVCTRRCV		Voltage control receiving block for GOOSE
ETHFRNT ETHLAN1 GATEWAY		Ethernet configuration of front port, LAN1 port and gateway
GOOSEDPRCV		GOOSE function block to receive a double point value
GOOSEINTRCV		GOOSE function block to receive an integer value
GOOSEMVRCV		GOOSE function block to receive a measurand value
GOOSESRCV		GOOSE function block to receive a single point value
<b>Scheme communication</b>		
ZCPSCH	85	Scheme communication logic with delta based blocking scheme signal transmit
ZCRWPSCH	85	Current reversal and weak end infeed logic for distance protection
ZCWSPSCH	85	Current reversal and weak end infeed logic for distance protection
ZCLCPLAL		Local acceleration logic
ECPSCH	85	Scheme communication logic for residual overcurrent protection
ECRWPSCH	85	Current reversal and weak end infeed logic for residual overcurrent protection

**Table 5:** *Basic IED functions*

IEC 61850 / Function block name	Function description
<b>Basic functions included in all products</b>	
INTERRSIG	Self-supervision with internal event list
SELSUPEVLST	Self-supervision with internal event list
TIMESYNCHGEN	Time synchronization
SNTP	Time synchronization
DTSBEGIN	Time synchronization
DTSEND	Time synchronization
TIMEZONE	Time synchronization
IRIG-B	Time synchronization
SETGRPS	Setting group handling
ACTVGRP	Parameter setting groups
TESTMODE	Test mode functionality
CHNGLCK	Change lock function
ATHSTAT	Authority status
ATHCHCK	Authority check
TERMINALID	IED identifiers
PRODINF	Product information

Table continues on next page

IEC 61850 / Function block name	Function description
PRIMVAL	Primary system values
SMAI_20_1 - SMAI_20_12	Signal Matrix for analog inputs
3PHSUM	Summation block 3 phase
GBASVAL	Global base values for settings
DOSFRNT	Denial of service, frame rate control for front port
DOSLAN1	Denial of service, frame rate control for LAN1 port
DOSSCKT	Denial of service, socket flow control

## Section 2 DNP3 overview

DNP3 is a set of communications protocols used between components in process automation systems. Its main use is in utilities such as electric and water companies. Usage in other industries is not common, although technically possible. Specifically, it was developed to facilitate communications between various types of data acquisition and control equipment. It plays a crucial role in SCADA systems, where it is used by SCADA master stations (aka Control Centers), RTUs, and IEDs.

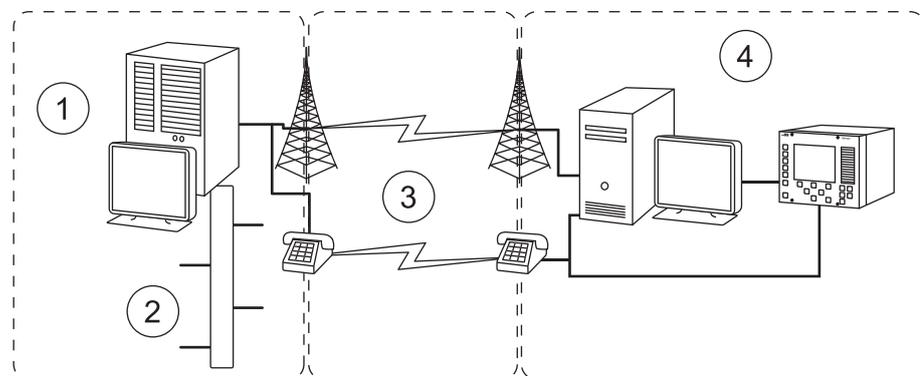


Figure 2: DNP3 communication schematic representation

- 1 SCADA master station / control center
- 2 External control points
- 3 Communication links (radio, microwave, spread-spectrum, twisted-pair, fibre-optics, dial-up, leased line)
- 4 Remote substation (station computer and IED)

### 2.1 DNP3 standard

The DNP3 protocol was developed by Westronic based on the early versions of the IEC 60870-5 standard telecontrol protocol specifications. Now the protocol specification is controlled by the DNP Users Group at [www.dnp.org](http://www.dnp.org).

The protocol is based on the EPA, a simplified model of the ISO/OSI model. It specifies the data link layer, the application layer and a transport pseudo-layer. To support advanced RTU functions and messages larger than the maximum frame length as defined by the IEC document 60870-5-1, the DNP3 data link is intended to be used with the mentioned transport pseudo-layer. As a minimum, this transport layer implements message assembly and disassembly services.

## Physical layer

Even though the standard does not specify the physical layer, it does however specify how to operate in a networked environment and also suggests how to avoid collisions between simultaneously sending devices.

Many implementations use serial communication based on RS-232, RS-485 or even fibre optics.

DNP3 can also be used over packet-oriented networks such as TCP/IP and UDP in which, for example, Ethernet may be used. In this case DNP3 can be said to be tunneled over TCP/IP or UDP.



Additional information on the DNP3 physical layer is available at the DNP Users Group at [www.dnp.org](http://www.dnp.org).

## Data link layer

The DNP3 data link layer is designed to operate with asynchronous or synchronous bit serial physical layers. Fully balanced transmission procedures were adopted to support spontaneous transmissions from outstations.

Data link functions include:

- Performing message data link retransmissions.
- Synchronizing and handling the FCB in the control octet.
- Setting and clearing the DFC bit based on buffer availability.
- Packing user data into the defined frame format includes CRC and transmitting the data to the physical layer.
- Unpacking the data link frame received from the physical layer into user data, checking and removing CRC.
- Controlling the physical layer.
- In unsolicited reporting mode, performing collision avoidance/detection procedures to ensure reliable transfer of data across the physical link.
- Responding to all valid frames received from the physical layer.

Data link responsibilities:

- Exchange of SDUs between peer DNP3 data links
- Error notification to data link user
- Sequencing of SDUs
- SDU delivery quality.

Link-layer confirm usage is not recommended and the implementation is optional. The IED does not request data-link layer confirmations for TCP/IP communication.



See the DNP technical bulletin TB1998-0402, section 3 for details at [www.dnp.org](http://www.dnp.org).

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### Transport pseudo-layer

To support advanced RTU functions and messages exceeding the maximum data link frame length, a transport pseudo-layer which implements message assembly and disassembly services was adopted.

Transport functions:

- Fragmenting user data into one or more data link frames and transmitting the data to the data link layer
- Assembling the data link frames received from the data link layer into user data
- Controlling all aspects of the data link excluding data link configuration

Transport responsibilities:

- Exchange of SDUs between peer DNP3 transport pseudo layers
- Error notification to transport users
- Sequencing of SDUs

### Application layer

The application layer is responsible for performing operations on data objects defined by the device or on the device itself. These operations include returning actual values (read function), assigning new values (write function) if the object represents control points, arming and energizing the output point (select, operate or direct operate functions) and if counters are used, reading actual values and clearing the counters. DNP3 uses the term point to identify an entity, and these entities can be categorized into point-types, such as analogs or binaries. Points are addressed by giving them an index number and an object is a formatted representation of data from a point. These objects can be assigned to classes in order to organize events and current values into categories. The DNP3 protocol defines four classes; 0 for static data (current value) and 1, 2 and 3 for event data.

### Communication modes

The IED supports four DNP3 communication modes.

- Quiescent operation
- Unsolicited report-by-exception operation
- Polled report-by-exception operation
- Polled static operation

## 2.2

### Documentation

This implementation of DNP3 is fully compliant with DNP3 Subset Definition Level 2, and contains significant functionality beyond Subset Level 2. See the device profile for further information.



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## Section 3 Vendor-specific implementation

### 3.1 DNP3 link modes

#### 3.1.1 DNP3 TCP/IP mode

DNP3 TCP/IP link mode is supported by the IED. This implementation supports up to four different masters communicating simultaneously with the IED. The IED is a listening endpoint implementation and listens for connections from DNP3 masters on a configurable port, *TCPIPLisPort*. The IED does not connect to masters, meaning that it is not a dual-endpoint implementation.

It is possible to use both the connection establishment method based on the master IP address, and the connection establishment method based on the port number. The identification and association of the master is based both on the IP address of the master and the port number it connects to. It is essential to make sure that the parameters *TCPIPLisPort*, *MasterIP-Addr*, *MasterIPNetMask*, *SlaveAddress* and *MasterAddress* uniquely identifies one master from the other masters.

The above is an important concept to grasp during commissioning so that no conflicts occur. Therefore, it is strongly recommended not to change the *MasterIPNetMask* parameter to anything else than its default 255.255.255.255 unless necessary. The parameter should not be mixed up with the subnet mask of the IP configuration. The *MasterIPNetMask* can be used to allow to accept connections from masters that do have dynamic IP addresses within a known range.

For example, if a master changes its IP address dynamically in the range of 10.10.10.1 and 10.10.10.254, the *MasterIPNetMask* could be set to 255.255.255.0 to allow for connections from this range. If two masters share this dynamic range or share the same IP address, it is necessary to separate them by having them connect to separate ports, for example, 20000 and 20001 respectively.

Also, *SlaveAddress* and *MasterAddress* must be correctly configured for each master. Otherwise, the previously accepted connection is closed upon the reception of the first DNP3 message.

The IED supports the requirements of the standard to receive UDP broadcast messages on the ports configured by *UDPPortAccData*. When operating in UDP-only mode, *UDPPortInitNULL* and *UDPPortCliMast* need to be configured as well.

As a default, the IED sends a keep-alive message in every 10 seconds according to the value of the *tKeepAliveT* parameter. The time can be changed, and setting it to zero means that no keep-alive messages are sent. It is important to know the hazards of disabling the keep-alive, and it is not recommended to do so unless

necessary. If the keep-alive messages are unwanted, it is better to increase the value of *tKeepAliveT* so that it exceeds the master's poll rate.

If a master crashes or the communication links are broken and the master restarts, the TCP/IP makes the IED believe that the connection still exists. Since the IED conforms to the recommendations of the standard not to accept new connections when a connection already exists to the particular master, the master will never be allowed to connect again. Another parameter that concerns the TCP/IP connection status is *tBrokenConTout*. It determines how long a session is active after a TCP/IP connection has been broken. After the time period, the session becomes inactive and events are not stored. If the parameter is set to 0, events are stored until the sequential buffers overflow. Note that if the parameter is set to zero, all events from start-up until the sequential buffers overflow are saved even though no connection would have been established.

Further documentation concerning DNP3 TCP/IP communication is available in the IP Networking document Volume 7, from [www.dnp.org](http://www.dnp.org).

## 3.2 Internal indications

Internal indications give information on certain status and error conditions within the outstation. They contain 2 octets of data and are found in the application layer on an outstation response.

See the DNP3 Specification Volume 3 Application Layer (Section 5 Detailed IIN Bit Descriptions) for more detailed descriptions of IIN bits.

**Table 6:** *Default class assignment for internal indications*

Bit index	Descriptions and conditions	Writable
IIN1.0	All stations – set after a broadcast message (any message using a destination address of 0xffff0 or above) has been received. Does not indicate an error condition	No
IIN1.1	Class 1 event data available. Can be set at any time and does not indicate an error condition.	No
IIN1.2	Class 2 event data available. Can be set at any time and does not indicate an error condition	No
IIN1.3	Class 3 event data available. Can be set at any time and does not indicate an error condition	No
IIN1.4	Time synchronization required from master. Can be set at any time and does not indicate an error condition. This bit is set according to the PST setting "tSyncTimeout" when time synchronization is via DNP3.	No
IIN1.5	Local mode. Set if some points are uncontrollable via DNP3. This bit is set when the IED is selected to Local control.	No
IIN1.6	Device trouble. Set if the IED has detected device problems. This bit is set when the IED's "Internal Fail" flag is set	No
IIN1.7	Device restart. Set only under specific conditions. Does not indicate an error condition	Yes
Table continues on next page		

Bit index	Descriptions and conditions	Writable
IIN2.0	Function unknown. Generally means that the function code (octet 2 of the request header) cannot be processed.	No
IIN2.1	Object unknown. Generally means that the function code could be processed but the object group / variation could not be processed	No
IIN2.2	Parameter error. Generally indicates that both function code and object group / variation could be processed but that the qualifier / range field is in error.	No
IIN2.3	Buffer overflow. Indicates that an event buffer has overflowed, and that change events, of at least one type, have been lost. Binary event buffer size is 1000. Counter event buffer size is 1000. Frozen event counter event are not supported. Analog event buffer size is 1000.	No
IIN2.4	Requested operation is already executing.	No
IIN2.5	Configuration corrupted.	No
IIN2.6	Reserved. Always 0.	No
IIN2.7	Reserved. Always 0.	No

### 3.3 Event reporting

The IED supports spontaneous reporting, that is, unsolicited reporting, of events. Given the parameters *UREvCntThold1*, *tUREvBufTout1*, *UREvCntThold2*, *tUREvBufTout2*, *UREvCntThold3* and *tUREvBufTout3*, the IED can be configured to report events either after a number of events of a certain class have been generated or when at least one event of the class has been generated and the configured time-span has elapsed.

The event system has a rate limiter to reduce CPU load. Each channel has a quota of 10 events/second. If the quota is exceeded the event channel is blocked until the event changes is below the quota.

#### 3.3.1 Event buffers

Binary input points, double-bit input points, counters and analog input points each have buffer sizes of 1000 events.

### 3.4 Command handling

DNP3 allows for operation on binary outputs via CROB. Direct Operate, Direct Operate with No Acknowledgement as well as Select/Operate pairs are allowed. The protocol requires that a pair of select and operate messages is completely alike and only one sequence number apart. This in turn requires masters not to send any requests between the selected message and the operate message, otherwise the operate request will be denied.

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Select and Operate requests may contain multiple objects. The select/control buffer size is large enough to hold 10 of the largest select requests possible.

### 3.4.1 Automation bits

Automation bit signals can be used to interpret and execute the count, on-time and off-time parameters of a CROB. Thereby pulse trains of different characteristics and lengths can be generated, and the outputs from the automation bits component can be connected to other function blocks in PCM600.

### 3.4.2 Apparatus control

Apparatuses can be controlled via DNP3. Open and close points to SCSWI are available for mapping in PCM600. These points can then be written to by as CROBs, thereby opening or closing the breaker. It is important to note that the control model, *ctlModel*, of the SCSWI is respected when set to *SBO Enh*. If *ctlModel* is set to *SBO Enh*, direct operate commands from DNP3 are not allowed. On the other hand, if *ctlModel* is set to *Dir Norm*, *SBO* commands from DNP3 are allowed.

Furthermore, the select timeout parameter *tSelectTimeout* in DNP3 should be set so that it harmonizes with the *tSelect* parameter of the SCSWI. The shortest of the two parameters dictates the timing of select/execute.

### 3.4.3 Binary output status points and control relay output blocks

While BOS points are included here for completeness, they are not often polled by DNP3 masters. BOS points represent the most recent value from a command operation for the corresponding CROB point. BOS points are not recommended to be included in class 0 polls.

As an alternative, it is recommended that actual status values affected by CROB points should be mapped as BI or DI. Requesting CROBs on the Open and Close points of SCSWI operate the breaker. The operation may take several seconds to complete. This means that a success response from the operate command may have been returned from the CROB even though the operation is still in progress. Therefore, the mentioned outputs from, for example, SCSWI need to be monitored as a complement.

This implies that the binary output object should not be assigned to classes 1, 2 or 3. A read of the binary outputs returns the last value written to that output.

## 3.5 Time synchronization

DNP3 supports time synchronization of the IED via object numbers 50...52. Time synchronization via DNP3 should only be used if time source with better accuracy

is not available, for example, IRIG-B, GPS or SNTP. For TCP/IP channels, the LAN procedure should be used, in which two separate messages are transmitted from the master, record current time and write, see DNP3 Specification Volume 5 for more information.



Parameters have to be set among the system wide time parameters as well as among the individual DNP3 masters.

DNP3 can be set for a coarse synchronization source under **Configuration/Time/Synchronisation/TimeSynch/CoarseSyncSrc** in the LHMI tree. Note that when DNP3 is set as coarse synchronization source, no fine synchronization source shall be configured. Otherwise, the time will jump between the fine and the coarse synchronization time sources.

Each DNP3 master configuration block has a number of parameters that affect the time synchronization. Only one master at a time is configured to set the time in the IED. Therefore, only one master configuration block enables the *DNPToSetTime* and *TSyncReqAfTout* parameter. That is, both parameters must have the same value and should only be set for one master at a time.

The *tSyncTimeout* parameter defines how long after a successful time synchronization the NeedTime IIN bit has to be set. The *tSyncReqAfTout* parameter defines if the *tSyncTimeout* should be used or not. Also, the IED supports both the new standard directive of use of UTC and local time for backward compatibility (*ExtTimeFormat*). If UTC is selected, the time in the time synchronization messages is expected to be in UTC, and vice versa.

## 3.6 Analog inputs

It is important to note that 16-bit and 32-bit variations of analog inputs are transmitted through DNP3 as signed numbers. The default analog input event buffer size is set 1000.

### 3.6.1 Analog data scaling

The four scaling options associated with analog input data reporting are None, Ratio, Multiplicative and Divisor. The selection *None* means that no scaling is performed on the source IEC 61850 value. The value is reported as such to DNP3.

#### Ratio, multiplicative and divisor scaling methods

The PCM600 tool contains four value arguments related to the scaling methods: *sourceMinVal*, *sourceMaxVal*, *destMinVal* and *destMaxVal*. The use of these arguments differs depending on the scaling method.

The ratio, multiplicative and divisor scaling methods use the first two arguments, *sourceMinVal* and *sourceMaxVal*, to define the source value range inside which the

object is to be used. The complete value range of the object is usually wanted even though the user could freely define the source range.

Arguments three and four, *destMinVal* and *destMaxVal*, define the destination value range. In ratio scaling, arguments *destMinVal* and *destMaxVal* define the corresponding range of the scaled, reported DNP3 value.

$$DNPvalue = (sourceValue - sourceMinVal) \left[ \frac{(destMaxVal - destMinVal)}{(sourceMaxVal - sourceMinVal)} \right] + destMinVal$$

(Equation 1)

In multiplicative scaling, argument four *destMaxVal* becomes a scale constant.

$$DNPvalue = sourceValue \times destMaxVal$$

(Equation 2)

In divisor scaling, argument four *destMaxVal* becomes a scale constant.

$$DNPvalue = \frac{sourceValue}{destMaxVal}$$

(Equation 3)

### 3.6.2 Analog input signal scaling for DNP3 master presentation

The presentation of an analog value in a telecontrol protocol varies between the different protocols and also with the age of the used protocol version. The range is from a simple 8 bit integer up to a double precision floating point. Internally in the IED many calculations are floating points.

PCM600 supports the re-scaling and the justification to the register presentation given by the project demands.

[Figure 3](#) presents a typical example of a signal flow in the IED from the CTs, VTs to the DNP3 master. The CT, VT is connected to the IED by the transformer module TRM. The SMAI function block is a preprocessor to calculate, check the signals for further use in application function blocks of type MMXU. MMXU calculates the RMS values for the most used analog signals like, U, I, P, Q, for example. The RMS values are available in floating point presentation as output signals of function blocks of type MMXU.

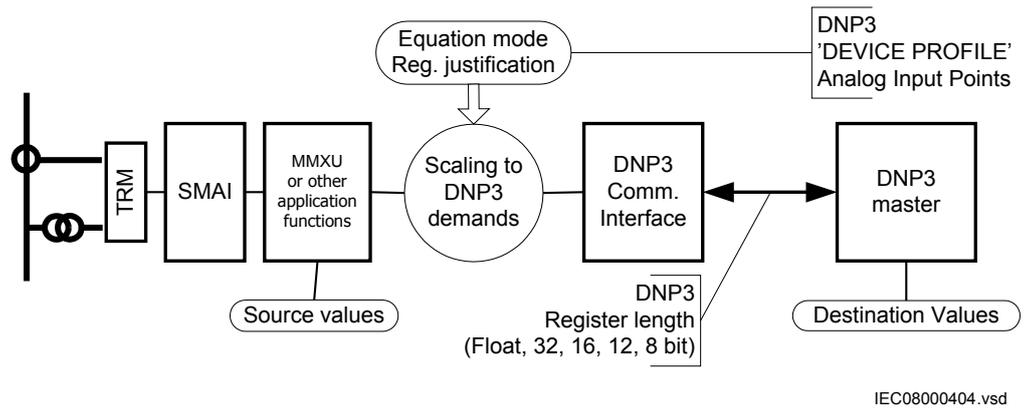
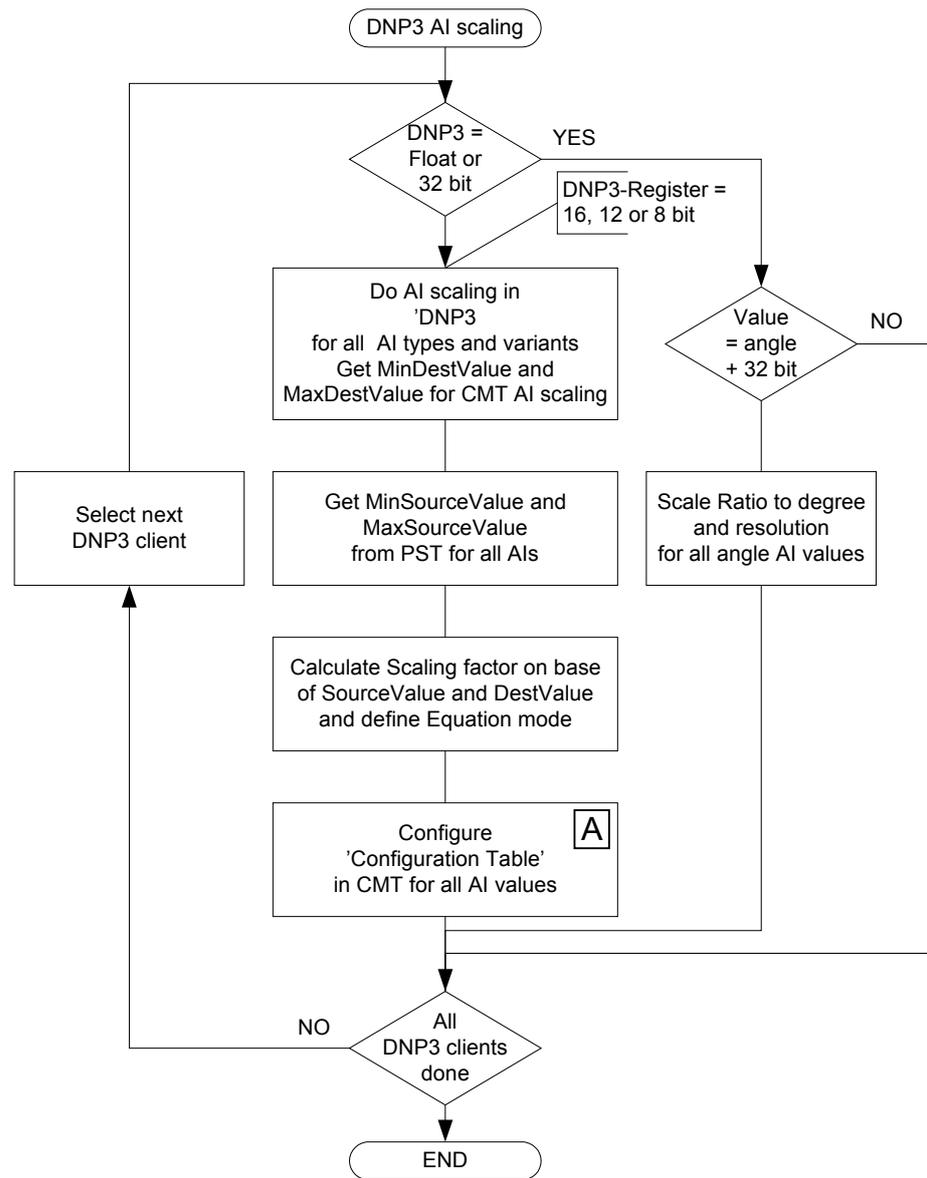


Figure 3: PCM600: Typical example of DNP3 scaling

The actual DNP3 specification defines 6 variations for the presentation of an analog value:

- Variation 1 - 32-bit with flag
- Variation 2 - 16-bit with flag
- Variation 3 - 32-bit without flag
- Variation 4 - 16-bit without flag
- Variation 5 - single-precision floating point with flag
- Variation 6 - double-precision floating point with flag

The IED supports all 32-bit and floating point variants without any additional scaling configuration. This is given as long as the *MaxSourceVal* (as it is given in the IED as floating point) is in the range of a 32-bit signed integer value (max. 32-bit = 2 147 483 648).



IEC08000407.vsd

Figure 4: CMT: Configuration Flowchart

### 3.7 DNP3 points



See the engineering manual for instructions on how to configure DNP3 with PCM600.

### 3.7.1 Point configuration

The DNP3 point map is configurable in PCM600. All points in the IED are unmapped as default. In PCM600, the unmapped points in the variables list on the left may be inserted to the active point list on the right.

Point gaps may be inserted if wanted. Point gaps cannot be read by the client.

### 3.7.2 Class assignment

Class assignment allows the events generated in the IED to be reported as DNP3 events. Some configurations exceed the class assignment possibilities defined by the standard.

**Table 7:** *DNP3 point map configuration*

Configuration	Description
None	Integrity class 0 scan returns gap. Value is available only via static scan. Point does not generate events.
Class 0	Point is returned in the class 0 scan. Point does not generate events.
Class 0 and any class 1,2,3 combination	Point is returned in the class 0 scan. Point generates events for the selected class or classes.
Class 1, 2 or 3 combination	Point is not returned in the class 0 scan. Point generates events for the selected class or classes.

BOS points exist only if the corresponding CROB point has been inserted in the active point list.

## 3.8 Fault record

Fault record is a mechanism to browse through disturbance records. It shows a snapshot of important information from each existing disturbance record.

Fault record contains signals that provide information on the current disturbance that the user of the *FaultRecord* has selected. It provides signals that help the user to iterate and browse through the existing disturbances. All the signals that can be used to iterate the fault records can be mapped as binary outputs in PCM600 and operated on with CROBs. All signals that provide information on the current disturbance can be mapped as analog inputs and read by the master. The DNP3 master navigates through the *FaultRecord* using the three signals:

- *GetFirstRec* fetches the oldest record in the *FaultRecord*.
- *GetNextRec* fetches the next record in time in the *FaultRecord* relative to the previously fetched record. If the previously fetched record is the newest, no fetch is done.
- *GetPrevRec* fetches the previous record in time in the *FaultRecord* relative to the previously fetched record. If the previously fetched record is the oldest, no fetch is done.

When a new disturbance is recorded, and the outputs are mapped to one of the event classes, events are generated, but the navigation in the *FaultRecord* is not affected. Hence, when the next command is sent from the DNP3 master, the fetched position is relative to the last fetch done; the position in the *FaultRecord* before the new disturbance occurred.

The output signals provide the fault record number, which is the number of the disturbance in the LHMI or PCM600, the number of faults in the IED, the active setting group at the time of the disturbance recording, the trigger signal identity, the time stamp at the trigger time as well as the fault location and the fault type. In addition, the magnitude, angle, fault magnitude and fault angle are provided for up to 30 of the analog channels connected to the disturbance recorder, and for the last 10 analog channels, the calculated value at the trigger time is provided.

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## Section 4 DNP3 parameters

### 4.1 Parameter descriptions

The DNP3 parameters for a specific IED can be accessed with PCM600 via **IED Configuration/Communication/Station Communication/DNP3.0**. There is one general setting for DNP3 (*Off/On*), available in function DNPGEN:1. This parameter must be *On* for the other parameters to have effect. Each communication channel has specific settings.

Function OPTICALPROT:1 is used to select if DNP3 or IEC60870-5-103 communication protocol shall be used for the serial optical port COM05 hardware module. Function RS485PROT:1 is used to select if DNP3 or IEC60870-5-103 communication protocol shall be used for the RS485 serial port on COM05 hardware module. When RS485 serial port is selected, also settings in function RS485GEN:1 must be considered.

There are specific settings for the serial channel depending on if the serial optical or RS485 interface is used. Communication specific settings for the serial optical interface are available in function OPTICALDNP:1 and communication specific settings for the RS485 interface are available in function RS485DNP:1. There are specific settings for the master sessions, available in function MSTSERIAL:1, when a master session occurs on the serial channel.

There are specific settings for the TCP/IP channel, available in functions CH1TCP to CH4TCP and MST1TCP to MS4TCP.

The channel blocks and the master blocks are separate but should be treated as pairs grouped together with a number. For example, CH1TCP and MST1TCP should be treated as an entity during engineering. The reason for this division is that it is conceptually possible to have multiple masters talking on the same channel, for example, a serial link, and it is also possible to imagine a single master switching between different channels, for example, different serial links.

#### **TCP/IP communication, CH1TCP - CH4TCP channels settings**

*TCPIPLisPort* defines the listen port if the channel is configured for TCP/IP. Default is 20000.

*UDPPortAccData* defines the port on which the UDP datagrams should be accepted if the channel is configured for networking. Default is 20000.

*UDPPortInitNUL* defines the master's destination port to which the initial NULL response should be sent if the channel is configured for networking. Default is 20000.

*UDPPortCliMast* defines the master's destination port to which responses should be sent if the channel is configured for networking. If the parameter is set to 0, the port number is taken from the previous request. Default is 0. There are specific settings for the master sessions if the master session occurs on the serial channel or on the TCP/IP channels.

*ApLayMaxRxSize* specifies the maximum application fragment size received in octets.

*ApLayMaxTxSize* specifies the maximum application fragment size transmitted in octets.



UDP is not supported in this release of 650 series. Do not use "UDP-only" for setting *Operation*.

### Master session settings for a specific communication channel ,MST1TCP - MST4TCP

*Operation* determines the operation of the master session. 0 = *Off*. 1 = *On*.

*SlaveAddress* defines the DNP3 address of this master session.

*MasterAddress* defines the DNP3 address that this master session uses for communication.

*ValMasterAddr* determines if the stack should validate the source address in receive frames. DNP3 frames contain both a source address field and a destination address field. If this parameter is set to 0, the stack does not validate the source address and thus the frames whose destination address matches the configured slave session are accepted. If this parameter is set to 1, both the source and the destination addresses have to match before the frame is accepted.



When going down in baudrate, the size of the configuration on DNP must be considered.

*MasterIP-Addr* defines the master's IP address.

*MasterIPNetMsk* determines the subnet mask that should be used to mask with the IP address.

*Obj1DefVar* determines the default variation for Object 1, Binary Inputs.

*Obj2DefVar* determines the default variation for Object 2, Binary Input Change Events.

*Obj3DefVar* determines the default variation for Object 3, Double Bit Inputs.

*Obj4DefVar* determines the default variation for Object 4, Double Bit Input Change Events.

*Obj10DefVar* determines the default variation for Object 10, Binary Output Status.

*Obj20DefVar* determines the default variation for Object 20, Binary Counters.

*Obj22DefVar* determines the default variation for Object 22, Binary Counter Change Events.

*Obj30DefVar* determines the default variation for Object 30, Analog Inputs.

*Obj32DefVar* determines the default variation for Object 32, Analog Change Events.

*AddrQueryEnbl* determines whether to enable self-address functionality on this master session (slave) as specified by the DNP Technical Bulletin 2003-003. Self-Address Reservation. The master session (Slave) responds to the address 0xfffc as if it had received a request for its configured address. It responds with its own address so that the master can automatically discover the slave address.

*tApplConfTout* specifies how long the slave waits for the application layer confirmation from the master. This in combination with *unsolRetryDelay* or *unsolOfflineRetryDelay* determines how frequently an unsolicited response is resent.

*ApplMultFrgRes* determines if the application layer of this master session in the slave is allowed to send multi fragment responses.

*ConfMultFrag* determines if application layer confirmations are requested for non-final fragments of a multi-fragment response. Application layer confirmations are always requested for responses that contain events.

*UREnable* determines if unsolicited responses are allowed. If set to 0, no unsolicited responses are generated and requests to enable or disable unsolicited responses fail.

*UREvClassMask* specifies the initial or new state of the unsolicited event mask. This mask is used to determine which event class or classes generate unsolicited responses. According to the DNP3 specification, unsolicited responses should be disabled until an Enable Unsolicited Response request is received from the master. Thus, this value should generally be 0. However, some masters do not generate the Enable Unsolicited Response message, in which case they must be enabled here. Keep the value to 0 for all other purposes.

*UOfflineRetry* specifies the maximum number of unsolicited retries before changing to the offline retry period. Up to 65535 retries can be specified. Set *UOfflineRetryDel* to the same value as *URRetryDelay* to define an infinite number of retries.

*tURRetryDelay* specifies in seconds the time to delay after an unsolicited confirm timeout before retrying the unsolicited response.

*tUOfflineRetryDel* specifies in seconds the time to delay after an unsolicited timeout before retrying the unsolicited response if *UOfflineRetry* has been attempted. To disable retries after *UOfflineRetry*, set this value to the maximum value of a stack timer: 31 days. This limits the retries to one in every 31 days.

*UREvCntThold1* If unsolicited responses are enabled, this parameter specifies the maximum number of events in class 1 to be allowed before an unsolicited response is generated.

*tUREvBufTout1* If unsolicited responses are enabled (UREnable), this parameter specifies the maximum amount of time in seconds before an unsolicited response is generated after an event in class 1 has been received.

*UREvCntThold2* If unsolicited responses are enabled (UREnable), this parameter specifies the maximum number of allowed class 2 events before an unsolicited response is generated.

*tUREvBufTout2* If unsolicited responses are enabled (UREnable), this parameter specifies the maximum amount of time in seconds before an unsolicited response is generated after an event in class 2 has been received.

*UREvCntThold3* If unsolicited responses are enabled (UREnable), this parameter specifies the maximum number of allowed class 3 events before an unsolicited response will be generated.

*tUREvBufTout3* If unsolicited responses are enabled (UREnable), this parameter specifies the maximum amount of time in seconds before an unsolicited response is generated after an event in class 3 has been received .

*DelOldBufFull* If this parameter is set to 1, the event with the earliest timeStamp is deleted when a new event is added to the full event queue.

*ExtTimeFormat* 0 = LocalTime. 1 = UTC.

*DNPToSetTime* determines if time synch messages received for this master session (slave) are allowed to set the local time in the IED.

*tSynchTimeout* sets the periodicity for time requests. That is, it defines how long after a succeeded time synch message from the master, the IIN.4 bit should be set.

*TsyncReqAfTout* determines if the stack should start with the IIN.4 bit set.

*Averag3TimeReq* determines if the IED needs three time synch messages to set the time. If set, the IIN.4 bit is high until three time synch messages are received. The average of the two best messages are used to set the time.

*PairedPoint* enables the Object12 Close request on an even-index point to access the next-index point.

*tSelectTimeout* specifies the maximum amount of time that a select remains valid before the corresponding operate is received.



The master subnet mask must not be changed unless the master gets its IP-address dynamically assigned via, for example, DHCP. For details see, [DNP3 TCP/IP mode](#)

*tBrokenConTout* determines how long a session is active after a TCP/IP connection has been broken. After that time period the master session becomes inactive and events are not stored. If the parameter is set to 0, events are stored until the buffers overflow.

*tKeepAliveT* determines, in seconds, how often the DNP3 master session sends keep-alive messages. Default is 10s.

## 4.1.1

### Serial optical and RS485 communication channel settings

#### RS485 specific communication channel settings, RS485GEN

*Wiremode* determines the wire mode if the device is configured for RS485. RS485 is a balanced serial communication that can be used in two ways:

- Two-wire
- Four-wire

A two-wire connection uses the same signal for RX and TX, and is a multidrop communication with no dedicated master or slave. This variant requires however a control of the output. The four-wire connection has separate signals for RX and TX multidrop communication with a dedicated master and the rest are slaves. No special control signal is needed in this case.

*BIAS* sets the bus bias *On* or *Off*.

#### Operation selection for RS485 and optical serial communication, OPTICALPROT and RS485PROT

*ProtocolSel* selects if the communication in RS485 and optical serial modes happens via *DNP* or *IEC 103* communication protocol. It can be *Off* via Parameter Setting tool or local HMI.

#### DNP3.0 for optical RS-232 and EIA-485 communication protocol, OPTICALDNP and RS485DNP

*BaudRate* specifies the baud rate on the serial.

*DLinkConfirm* determines when the stack should ask for link layer confirmations. Since DNP3 supports breaking an application layer message into multiple link layer frames, set to the following based on the desired operation for a specific communication session:

- *Never* - not for any frame
- *Sometimes* - only for multiframe message fragments
- *Always* - for all frames

*tDLinkTimeout* specifies the maximum amount of time to wait for a link level confirm if requested (that is, if *DLinkConfirm* is *On*). Even if *DLinkConfirm* is set to *Never*, this will be used for linktest frame and request link status if they are sent.

*DLinkRetries* is the maximum number of link layer retries if data-link layer confirms time up.

*tRxToTxMinDel* is the minimum time (in seconds) after receiving a character, before another attempt to transmit a character on this channel. This is generally useful when using a modem or some other communication device that requires a minimum time between receive and transmit.

*ApLayMaxRxSize* specifies the maximum application fragment size received in octets.

*ApLayMaxTxSize* specifies the maximum application fragment size transmitted in octets.

*Stopbit* defines the number of stop bits for the serial port.

*Parity* defines the parity to use for the serial port it can be set to:

- *None* - no parity used
- *Even* - even parity used
- *Odd* - odd parity used

*tRTSWarmUp* configures transmitter warm-up and warm-down delay times (in milliseconds). If warm-up is configured to non-zero then at start of the send, the transmitter is *On*. This means that the line is driven but the data send of the start is delayed by the warm-up delay time.

*tRTSWarmDown* specifies that if warm-down is configured to non zero then at end of the send, the transmitter deactivation is delayed by the warm-down time.

*tBackOffDelay* specifies that if the data send is started, a check is made if data is being received at that time. If yes, a back-off timer is started and when it times out, a check is made again to see if line is idle. If no, a new back-off timer is started. This is repeated until the line is idle and send can start. Line idle is determined when nothing is received for more than a character time. The back-off time consists of a configurable fixed time and a random time where the maximum random time is also configurable. The back-off feature is always on.

*tMaxRndDelBkOf* specifies the configurable RS485 maximum back-off random time delay in seconds.

*HWCollisionDetect* with COM05, a new collision detect feature in hardware is implemented to improve the sensitivity for collision detection. The performance of this feature depends on parameters of the RS485 network as well as the protocol behaviour. It can even have negative impact on performance in some circumstances, therefore usage of the feature should be tested and adapted for each specific installation.



*HWCollisionDetect* is only used for RS485 networks, thus is only available in RS485DNP function.

## Master session settings for RS485 communication channel, MSTSERIAL

*ChToAssociate* defines the channel, to which this master session should be associated to.



The MSTSERIAL function includes the same settings as the MS1TCP to MS4TCP functions, except the *ChToAssociate* setting which is used to select either the serial optical or RS485 communication interface on COM05 hardware module.

## 4.2 Parameter list

### 4.2.1 Parameter list for optical and RS485 communication channel

**Table 8:** *RS485GEN Non group settings (basic)*

Name	Values (Range)	Unit	Step	Default	Description
WireMode	Four-wire Two-wire	-	-	Four-wire	Two or four wire mode
BIAS	Off On	-	-	Off	Bus biasing on/off

**Table 9:** *RS485PROT Non group settings (basic)*

Name	Values (Range)	Unit	Step	Default	Description
ProtocolSel	Off DNP IEC103	-	-	Off	Protocol selection

**Table 10:** *OPTICALPROT Non group settings (basic)*

Name	Values (Range)	Unit	Step	Default	Description
ProtocolSel	Off DNP IEC103	-	-	Off	Protocol selection

**Table 11:** *DNPGEN Non group settings (basic)*

Name	Values (Range)	Unit	Step	Default	Description
Operation	Off On	-	-	Off	Operation mode Off / On

**Table 12:** *MSTSERIAL Non group settings (basic)*

Name	Values (Range)	Unit	Step	Default	Description
Operation	Off On	-	-	Off	Operation Off / On
ChToAssociate	RS485 Optical	-	-	RS485	Channel to associate to
SlaveAddress	0 - 65519	-	1	1	Slave address
MasterAddress	0 - 65519	-	1	1	Master address
Obj1DefVar	1:BI SingleBit 2:BI WithStatus	-	-	1:BI SingleBit	Object 1, default variation
Obj2DefVar	1:BIChWithoutTime 2:BIChWithTime 3:BIChWithRelTime	-	-	3:BIChWithRelTime	Object 2, default variation
Obj3DefVar	1:DIWithoutFlag 2:DIWithFlag	-	-	1:DIWithoutFlag	Object 3, default variation
Obj4DefVar	1:DIChWithoutTime 2:DIChWithTime 3:DIChWithRelTime	-	-	3:DIChWithRelTime	Object 4, default variation
Obj10DefVar	1:BO 2:BOStatus	-	-	2:BOStatus	Object 10, default variation
Obj20DefVar	1:BinCnt32 2:BinCnt16 5:BinCnt32WoutF 6:BinCnt16WoutF	-	-	5:BinCnt32WoutF	Object 20, default variation
Obj22DefVar	1:BinCnt32EvWoutT 2:BinCnt16EvWoutT 5:BinCnt32EvWithT 6:BinCnt16EvWithT	-	-	1:BinCnt32EvWoutT	Object 22, default variation
Obj30DefVar	1:AI32Int 2:AI16Int 3:AI32IntWithoutF 4:AI16IntWithoutF 5:AI32FitWithF 6:AI64FitWithF	-	-	3:AI32IntWithoutF	Object 30, default variation
Obj32DefVar	1:AI32IntEvWoutF 2:AI16IntEvWoutF 3:AI32IntEvWithFT 4:AI16IntEvWithFT 5:AI32FitEvWithF 6:AI64FitEvWithF 7:AI32FitEvWithFT 8:AI64FitEvWithFT	-	-	1:AI32IntEvWoutF	Object 32, default variation

**Table 13:** *MSTSERIAL Non group settings (advanced)*

Name	Values (Range)	Unit	Step	Default	Description
ValMasterAddr	No Yes	-	-	Yes	Validate source (master) address
AddrQueryEnbl	No Yes	-	-	Yes	Address query enable
tApplConfTout	0.00 - 300.00	s	0.01	10.00	Application layer confirm timeout
ApplMultFrgRes	No Yes	-	-	Yes	Enable application for multiple fragment response
ConfMultFrag	No Yes	-	-	Yes	Confirm each multiple fragment
UREnable	No Yes	-	-	Yes	Unsolicited response enabled
UREvClassMask	Off Class 1 Class 2 Class 1 and 2 Class 3 Class 1 and 3 Class 2 and 3 Class 1, 2 and 3	-	-	Off	Unsolicited response, event class mask
UROfflineRetry	0 - 10	-	1	5	Unsolicited response retries before off-line retry mode
tURRetryDelay	0.00 - 60.00	s	0.01	5.00	Unsolicited response retry delay in s
tUROfflRtryDel	0.00 - 60.00	s	0.01	30.00	Unsolicited response off-line retry delay in s
UREvCntThold1	1 - 100	-	1	5	Unsolicited response class 1 event count report treshold
tUREvBufTout1	0.00 - 60.00	s	0.01	5.00	Unsolicited response class 1 event buffer timeout
UREvCntThold2	1 - 100	-	1	5	Unsolicited response class 2 event count report treshold
tUREvBufTout2	0.00 - 60.00	s	0.01	5.00	Unsolicited response class 2 event buffer timeout
UREvCntThold3	1 - 100	-	1	5	Unsolicited response class 3 event count report treshold
tUREvBufTout3	0.00 - 60.00	s	0.01	5.00	Unsolicited response class 3 event buffer timeout
DelOldBuffFull	No Yes	-	-	No	Delete oldest event when buffer is full
ExtTimeFormat	LocalTime UTC	-	-	UTC	External time format
DNPToSetTime	No Yes	-	-	Yes	Allow DNP to set time in IED
tSynchTimeout	30 - 3600	s	1	1800	Time synch timeout before error status is generated
TSyncReqAfTout	No Yes	-	-	No	Time synchronization request after timeout

Table continues on next page

Name	Values (Range)	Unit	Step	Default	Description
Averag3TimeReq	No Yes	-	-	No	Use average of 3 time requests
PairedPoint	No Yes	-	-	Yes	Enable paired point
tSelectTimeout	1.0 - 60.0	s	0.1	30.0	Select timeout

**Table 14:** *OPTICALDNP Non group settings (basic)*

Name	Values (Range)	Unit	Step	Default	Description
BaudRate	300 Bd 600 Bd 1200 Bd 2400 Bd 4800 Bd 9600 Bd 19200 Bd 38400 Bd 57600 Bd 115200 Bd	-	-	9600 Bd	Baud-rate for serial port

**Table 15:** *OPTICALDNP Non group settings (advanced)*

Name	Values (Range)	Unit	Step	Default	Description
DLinkConfirm	Never Sometimes Always	-	-	Never	Data-link confirm
tDLinkTimeout	0.000 - 60.000	s	0.001	2.000	Data-link confirm timeout in s
DLinkRetries	0 - 255	-	1	3	Data-link maximum retries
tRxToTxMinDel	0.000 - 60.000	s	0.001	0.000	Rx to Tx minimum delay in s
ApLayMaxRxSize	20 - 2048	-	1	2048	Application layer maximum Rx fragment size
ApLayMaxTxSize	20 - 2048	-	1	2048	Application layer maximum Tx fragment size
StopBits	1 - 2	-	1	1	Stop bits
Parity	No Even Odd	-	-	Even	Parity
tRTSWarmUp	0.000 - 60.000	s	0.001	0.000	RTS warm-up in s
tRTSWarmDown	0.000 - 60.000	s	0.001	0.000	RTS warm-down in s
tBackOffDelay	0.000 - 60.000	s	0.001	0.050	RS485 back-off delay in s
tMaxRndDelBkOf	0.000 - 60.000	s	0.001	0.100	RS485 maximum back-off random delay in s

**Table 16:** *RS485DNP Non group settings (basic)*

Name	Values (Range)	Unit	Step	Default	Description
BaudRate	300 Bd 600 Bd 1200 Bd 2400 Bd 4800 Bd 9600 Bd 19200 Bd 38400 Bd 57600 Bd 115200 Bd	-	-	9600 Bd	Baud-rate for serial port

**Table 17:** *RS485DNP Non group settings (advanced)*

Name	Values (Range)	Unit	Step	Default	Description
DLinkConfirm	Never Sometimes Always	-	-	Never	Data-link confirm
tDLinkTimeout	0.000 - 60.000	s	0.001	2.000	Data-link confirm timeout in s
DLinkRetries	0 - 255	-	1	3	Data-link maximum retries
tRxToTxMinDel	0.000 - 60.000	s	0.001	0.000	Rx to Tx minimum delay in s
ApLayMaxRxSize	20 - 2048	-	1	2048	Application layer maximum Rx fragment size
ApLayMaxTxSize	20 - 2048	-	1	2048	Application layer maximum Tx fragment size
StopBits	1 - 2	-	1	1	Stop bits
Parity	No Even Odd	-	-	Even	Parity
tRTSWarmUp	0.000 - 60.000	s	0.001	0.000	RTS warm-up in s
tRTSWarmDown	0.000 - 60.000	s	0.001	0.000	RTS warm-down in s
tBackOffDelay	0.000 - 60.000	s	0.001	0.050	RS485 back-off delay in s
tMaxRndDelBkOf	0.000 - 60.000	s	0.001	0.100	RS485 maximum back-off random delay in s
HWCollisionDetect	Off On	-	-	Off	HW collision detection

## 4.2.2 Parameter list for TCP/IP

**Table 18:** CH1TCP Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
Operation	Off TCP/IP UDP-Only	-	-	Off	Operation mode
TCPIPLisPort	1 - 65535	-	1	20000	TCP/IP listen port
UDPPortAccData	1 - 65535	-	1	20000	UDP port to accept UDP datagrams from master
UDPPortInitNUL	1 - 65535	-	1	20000	UDP port for initial NULL response
UDPPortCliMast	0 - 65535	-	1	0	UDP port to remote client/master

**Table 19:** CH1TCP Non group settings (advanced)

Name	Values (Range)	Unit	Step	Default	Description
ApLayMaxRxSize	20 - 2048	-	1	2048	Application layer maximum Rx fragment size
ApLayMaxTxSize	20 - 2048	-	1	2048	Application layer maximum Tx fragment size

**Table 20:** CH2TCP Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
Operation	Off TCP/IP UDP-Only	-	-	Off	Operation mode
TCPIPLisPort	1 - 65535	-	1	20000	TCP/IP listen port
UDPPortAccData	1 - 65535	-	1	20000	UDP port to accept UDP datagrams from master
UDPPortInitNUL	1 - 65535	-	1	20000	UDP port for initial NULL response
UDPPortCliMast	0 - 65535	-	1	0	UDP port to remote client/master

**Table 21:** CH2TCP Non group settings (advanced)

Name	Values (Range)	Unit	Step	Default	Description
ApLayMaxRxSize	20 - 2048	-	1	2048	Application layer maximum Rx fragment size
ApLayMaxTxSize	20 - 2048	-	1	2048	Application layer maximum Tx fragment size

**Table 22:** CH3TCP Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
Operation	Off TCP/IP UDP-Only	-	-	Off	Operation mode
TCPIPLisPort	1 - 65535	-	1	20000	TCP/IP listen port
UDPPortAccData	1 - 65535	-	1	20000	UDP port to accept UDP datagrams from master
UDPPortInitNUL	1 - 65535	-	1	20000	UDP port for initial NULL response
UDPPortCliMast	0 - 65535	-	1	0	UDP port to remote client/master

**Table 23:** CH3TCP Non group settings (advanced)

Name	Values (Range)	Unit	Step	Default	Description
ApLayMaxRxSize	20 - 2048	-	1	2048	Application layer maximum Rx fragment size
ApLayMaxTxSize	20 - 2048	-	1	2048	Application layer maximum Tx fragment size

**Table 24:** CH4TCP Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
Operation	Off TCP/IP UDP-Only	-	-	Off	Operation mode
TCPIPLisPort	1 - 65535	-	1	20000	TCP/IP listen port
UDPPortAccData	1 - 65535	-	1	20000	UDP port to accept UDP datagrams from master
UDPPortInitNUL	1 - 65535	-	1	20000	UDP port for initial NULL response
UDPPortCliMast	0 - 65535	-	1	0	UDP port to remote client/master

**Table 25:** CH4TCP Non group settings (advanced)

Name	Values (Range)	Unit	Step	Default	Description
ApLayMaxRxSize	20 - 2048	-	1	2048	Application layer maximum Rx fragment size
ApLayMaxTxSize	20 - 2048	-	1	2048	Application layer maximum Tx fragment size

**Table 26:** MST1TCP Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
Operation	Off On	-	-	Off	Operation Off / On
SlaveAddress	0 - 65519	-	1	1	Slave address
MasterAddress	0 - 65519	-	1	1	Master address

Table continues on next page

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Name	Values (Range)	Unit	Step	Default	Description
ValMasterAddr	No Yes	-	-	Yes	Validate source (master) address
MasterIP-Addr	0 - 18	IP Address	1	0.0.0.0	Master IP-address
MasterIPNetMsk	0 - 18	IP Address	1	255.255.255.255	Master IP net mask
Obj1DefVar	1:BI SingleBit 2:BI WithStatus	-	-	1:BI SingleBit	Object 1, default variation
Obj2DefVar	1:BICh WithoutTime 2:BICh WithTime 3:BICh WithRelTime	-	-	3:BICh WithRelTime	Object 2, default variation
Obj3DefVar	1:DI WithoutFlag 2:DI WithFlag	-	-	1:DI WithoutFlag	Object 3, default variation
Obj4DefVar	1:DICh WithoutTime 2:DICh WithTime 3:DICh WithRelTime	-	-	3:DICh WithRelTime	Object 4, default variation
Obj10DefVar	1:BO 2:BOStatus	-	-	2:BOStatus	Object 10, default variation
Obj20DefVar	1:BinCnt32 2:BinCnt16 5:BinCnt32WoutF 6:BinCnt16WoutF	-	-	5:BinCnt32WoutF	Object 20, default variation
Obj22DefVar	1:BinCnt32EvWoutT 2:BinCnt16EvWoutT 5:BinCnt32EvWithT 6:BinCnt16EvWithT	-	-	1:BinCnt32EvWoutT	Object 22, default variation
Obj30DefVar	1:AI32Int 2:AI16Int 3:AI32IntWithoutF 4:AI16IntWithoutF 5:AI32FitWithF 6:AI64FitWithF	-	-	3:AI32IntWithoutF	Object 30, default variation
Obj32DefVar	1:AI32IntEvWoutF 2:AI16IntEvWoutF 3:AI32IntEvWithFT 4:AI16IntEvWithFT 5:AI32FitEvWithF 6:AI64FitEvWithF 7:AI32FitEvWithFT 8:AI64FitEvWithFT	-	-	1:AI32IntEvWoutF	Object 32, default variation

**Table 27:** *MST1TCP Non group settings (advanced)*

Name	Values (Range)	Unit	Step	Default	Description
AddrQueryEnbl	No Yes	-	-	Yes	Address query enable
tApplConfTout	0.00 - 300.00	s	0.01	10.00	Application layer confirm timeout
ApplMultFrgRes	No Yes	-	-	Yes	Enable application for multiple fragment response
ConfMultFrag	No Yes	-	-	Yes	Confirm each multiple fragment
UREnable	No Yes	-	-	Yes	Unsolicited response enabled
UREvClassMask	Off Class 1 Class 2 Class 1 and 2 Class 3 Class 1 and 3 Class 2 and 3 Class 1, 2 and 3	-	-	Off	Unsolicited response, event class mask
UROfflineRetry	0 - 10	-	1	5	Unsolicited response retries before off-line retry mode
tURRetryDelay	0.00 - 60.00	s	0.01	5.00	Unsolicited response retry delay in s
tUROfflRtryDel	0.00 - 60.00	s	0.01	30.00	Unsolicited response off-line retry delay in s
UREvCntThold1	1 - 100	-	1	5	Unsolicited response class 1 event count report threshold
tUREvBufTout1	0.00 - 60.00	s	0.01	5.00	Unsolicited response class 1 event buffer timeout
UREvCntThold2	1 - 100	-	1	5	Unsolicited response class 2 event count report threshold
tUREvBufTout2	0.00 - 60.00	s	0.01	5.00	Unsolicited response class 2 event buffer timeout
UREvCntThold3	1 - 100	-	1	5	Unsolicited response class 3 event count report threshold
tUREvBufTout3	0.00 - 60.00	s	0.01	5.00	Unsolicited response class 3 event buffer timeout
DelOldBuffFull	No Yes	-	-	No	Delete oldest event when buffer is full
ExtTimeFormat	LocalTime UTC	-	-	UTC	External time format
DNPToSetTime	No Yes	-	-	No	Allow DNP to set time in IED
tSynchTimeout	30 - 3600	s	1	1800	Time synch timeout before error status is generated
TSyncReqAfTout	No Yes	-	-	No	Time synchronization request after timeout
Averag3TimeReq	No Yes	-	-	No	Use average of 3 time requests
PairedPoint	No Yes	-	-	Yes	Enable paired point

Table continues on next page

Name	Values (Range)	Unit	Step	Default	Description
tSelectTimeout	1.0 - 60.0	s	0.1	30.0	Select timeout
tBrokenConTout	0 - 3600	s	1	0	Broken connection timeout
tKeepAliveT	0 - 3600	s	1	10	Keep-Alive timer

**Table 28: MST2TCP Non group settings (basic)**

Name	Values (Range)	Unit	Step	Default	Description
Operation	Off On	-	-	Off	Operation Off / On
SlaveAddress	0 - 65519	-	1	1	Slave address
MasterAddress	0 - 65519	-	1	1	Master address
ValMasterAddr	No Yes	-	-	Yes	Validate source (master) address
MasterIP-Addr	0 - 18	IP Address	1	0.0.0.0	Master IP-address
MasterIPNetMsk	0 - 18	IP Address	1	255.255.255.255	Master IP net mask
Obj1DefVar	1:BI SingleBit 2:BI WithStatus	-	-	1:BI SingleBit	Object 1, default variation
Obj2DefVar	1:BIChWithoutTime 2:BIChWithTime 3:BIChWithRelTime	-	-	3:BIChWithRelTime	Object 2, default variation
Obj3DefVar	1:DIWithoutFlag 2:DIWithFlag	-	-	1:DIWithoutFlag	Object 3, default variation
Obj4DefVar	1:DIChWithoutTime 2:DIChWithTime 3:DIChWithRelTime	-	-	3:DIChWithRelTime	Object 4, default variation
Obj10DefVar	1:BO 2:BOStatus	-	-	2:BOStatus	Object 10, default variation
Obj20DefVar	1:BinCnt32 2:BinCnt16 5:BinCnt32WoutF 6:BinCnt16WoutF	-	-	5:BinCnt32WoutF	Object 20, default variation

Table continues on next page

Name	Values (Range)	Unit	Step	Default	Description
Obj22DefVar	1:BinCnt32EvWout T 2:BinCnt16EvWout T 5:BinCnt32EvWith T 6:BinCnt16EvWith T	-	-	1:BinCnt32EvWout tT	Object 22, default variation
Obj30DefVar	1:AI32Int 2:AI16Int 3:AI32IntWithoutF 4:AI16IntWithoutF 5:AI32FItWithF 6:AI64FItWithF	-	-	3:AI32IntWithoutF	Object 30, default variation
Obj32DefVar	1:AI32IntEvWoutF 2:AI16IntEvWoutF 3:AI32IntEvWithFT 4:AI16IntEvWithFT 5:AI32FItEvWithF 6:AI64FItEvWithF 7:AI32FItEvWithFT 8:AI64FItEvWithFT	-	-	1:AI32IntEvWoutF	Object 32, default variation

**Table 29:** *MST2TCP Non group settings (advanced)*

Name	Values (Range)	Unit	Step	Default	Description
AddrQueryEnbl	No Yes	-	-	Yes	Address query enable
tApplConfTout	0.00 - 300.00	s	0.01	10.00	Application layer confirm timeout
ApplMultFrgRes	No Yes	-	-	Yes	Enable application for multiple fragment response
ConfMultFrag	No Yes	-	-	Yes	Confirm each multiple fragment
UREnable	No Yes	-	-	Yes	Unsolicited response enabled
UREvClassMask	Off Class 1 Class 2 Class 1 and 2 Class 3 Class 1 and 3 Class 2 and 3 Class 1, 2 and 3	-	-	Off	Unsolicited response, event class mask
UROfflineRetry	0 - 10	-	1	5	Unsolicited response retries before off-line retry mode
tURRetryDelay	0.00 - 60.00	s	0.01	5.00	Unsolicited response retry delay in s
tUROfflRtryDel	0.00 - 60.00	s	0.01	30.00	Unsolicited response off-line retry delay in s
UREvCntThold1	1 - 100	-	1	5	Unsolicited response class 1 event count report treshold
tUREvBufTout1	0.00 - 60.00	s	0.01	5.00	Unsolicited response class 1 event buffer timeout
UREvCntThold2	1 - 100	-	1	5	Unsolicited response class 2 event count report treshold

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Name	Values (Range)	Unit	Step	Default	Description
tUREvBufTout2	0.00 - 60.00	s	0.01	5.00	Unsolicited response class 2 event buffer timeout
UREvCntThold3	1 - 100	-	1	5	Unsolicited response class 3 event count report treshold
tUREvBufTout3	0.00 - 60.00	s	0.01	5.00	Unsolicited response class 3 event buffer timeout
DelOldBufFull	No Yes	-	-	No	Delete oldest event when buffer is full
ExtTimeFormat	LocalTime UTC	-	-	UTC	External time format
DNPToSetTime	No Yes	-	-	No	Allow DNP to set time in IED
tSynchTimeout	30 - 3600	s	1	1800	Time synch timeout before error status is generated
TSyncReqAfTOut	No Yes	-	-	No	Time synchronization request after timeout
Averag3TimeReq	No Yes	-	-	No	Use average of 3 time requests
PairedPoint	No Yes	-	-	Yes	Enable paired point
tSelectTimeout	1.0 - 60.0	s	0.1	30.0	Select timeout
tBrokenConTout	0 - 3600	s	1	0	Broken connection timeout
tKeepAliveT	0 - 3600	s	1	10	Keep-Alive timer

**Table 30:** *MST3TCP Non group settings (basic)*

Name	Values (Range)	Unit	Step	Default	Description
Operation	Off On	-	-	Off	Operation Off / On
SlaveAddress	0 - 65519	-	1	1	Slave address
MasterAddress	0 - 65519	-	1	1	Master address
ValMasterAddr	No Yes	-	-	Yes	Validate source (master) address
MasterIP-Addr	0 - 18	IP Address	1	0.0.0.0	Master IP-address
MasterIPNetMsk	0 - 18	IP Address	1	255.255.255.255	Master IP net mask
Obj1DefVar	1:BI SingleBit 2:BI WithStatus	-	-	1:BI SingleBit	Object 1, default variation
Obj2DefVar	1:BIChWithoutTime 2:BIChWithTime 3:BIChWithRelTime	-	-	3:BIChWithRelTime	Object 2, default variation
Obj3DefVar	1:DIWithoutFlag 2:DIWithFlag	-	-	1:DIWithoutFlag	Object 3, default variation

Table continues on next page

Name	Values (Range)	Unit	Step	Default	Description
Obj4DefVar	1:DIChWithoutTime 2:DIChWithTime 3:DIChWithRelTime	-	-	3:DIChWithRelTime	Object 4, default variation
Obj10DefVar	1:BO 2:BOStatus	-	-	2:BOStatus	Object 10, default variation
Obj20DefVar	1:BinCnt32 2:BinCnt16 5:BinCnt32WoutF 6:BinCnt16WoutF	-	-	5:BinCnt32WoutF	Object 20, default variation
Obj22DefVar	1:BinCnt32EvWoutT 2:BinCnt16EvWoutT 5:BinCnt32EvWithT 6:BinCnt16EvWithT	-	-	1:BinCnt32EvWoutT	Object 22, default variation
Obj30DefVar	1:AI32Int 2:AI16Int 3:AI32IntWithoutF 4:AI16IntWithoutF 5:AI32FitWithF 6:AI64FitWithF	-	-	3:AI32IntWithoutF	Object 30, default variation
Obj32DefVar	1:AI32IntEvWoutF 2:AI16IntEvWoutF 3:AI32IntEvWithFT 4:AI16IntEvWithFT 5:AI32FitEvWithF 6:AI64FitEvWithF 7:AI32FitEvWithFT 8:AI64FitEvWithFT	-	-	1:AI32IntEvWoutF	Object 32, default variation

**Table 31:** *MST3TCP Non group settings (advanced)*

Name	Values (Range)	Unit	Step	Default	Description
AddrQueryEnbl	No Yes	-	-	Yes	Address query enable
tApplConfTOut	0.00 - 300.00	s	0.01	10.00	Application layer confirm timeout
ApplMultFrgRes	No Yes	-	-	Yes	Enable application for multiple fragment response
ConfMultFrag	No Yes	-	-	Yes	Confirm each multiple fragment
UREnable	No Yes	-	-	Yes	Unsolicited response enabled
UREvClassMask	Off Class 1 Class 2 Class 1 and 2 Class 3 Class 1 and 3 Class 2 and 3 Class 1, 2 and 3	-	-	Off	Unsolicited response, event class mask

Table continues on next page

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Name	Values (Range)	Unit	Step	Default	Description
UOfflineRetry	0 - 10	-	1	5	Unsolicited response retries before off-line retry mode
tURRetryDelay	0.00 - 60.00	s	0.01	5.00	Unsolicited response retry delay in s
tUROfflRtryDel	0.00 - 60.00	s	0.01	30.00	Unsolicited response off-line retry delay in s
UREvCntThold1	1 - 100	-	1	5	Unsolicited response class 1 event count report treshold
tUREvBufTout1	0.00 - 60.00	s	0.01	5.00	Unsolicited response class 1 event buffer timeout
UREvCntThold2	1 - 100	-	1	5	Unsolicited response class 2 event count report treshold
tUREvBufTout2	0.00 - 60.00	s	0.01	5.00	Unsolicited response class 2 event buffer timeout
UREvCntThold3	1 - 100	-	1	5	Unsolicited response class 3 event count report treshold
tUREvBufTout3	0.00 - 60.00	s	0.01	5.00	Unsolicited response class 3 event buffer timeout
DelOldBufFull	No Yes	-	-	No	Delete oldest event when buffer is full
ExtTimeFormat	LocalTime UTC	-	-	UTC	External time format
DNPToSetTime	No Yes	-	-	No	Allow DNP to set time in IED
tSynchTimeout	30 - 3600	s	1	1800	Time synch timeout before error status is generated
TSyncReqAfTout	No Yes	-	-	No	Time synchronization request after timeout
Averag3TimeReq	No Yes	-	-	No	Use average of 3 time requests
PairedPoint	No Yes	-	-	Yes	Enable paired point
tSelectTimeout	1.0 - 60.0	s	0.1	30.0	Select timeout
tBrokenConTout	0 - 3600	s	1	0	Broken connection timeout
tKeepAliveT	0 - 3600	s	1	10	Keep-Alive timer

**Table 32:** *MST4TCP Non group settings (basic)*

Name	Values (Range)	Unit	Step	Default	Description
Operation	Off On	-	-	Off	Operation Off / On
SlaveAddress	0 - 65519	-	1	1	Slave address
MasterAddress	0 - 65519	-	1	1	Master address
ValMasterAddr	No Yes	-	-	Yes	Validate source (master) address
MasterIP-Addr	0 - 18	IP Address	1	0.0.0.0	Master IP-address

Table continues on next page

Name	Values (Range)	Unit	Step	Default	Description
MasterIPNetMsk	0 - 18	IP Address	1	255.255.255.255	Master IP net mask
Obj1DefVar	1:BI SingleBit 2:BI WithStatus	-	-	1:BI SingleBit	Object 1, default variation
Obj2DefVar	1:BICh WithoutTime 2:BICh WithTime 3:BICh WithRelTime	-	-	3:BICh WithRelTime	Object 2, default variation
Obj3DefVar	1:DI WithoutFlag 2:DI WithFlag	-	-	1:DI WithoutFlag	Object 3, default variation
Obj4DefVar	1:DICH WithoutTime 2:DICH WithTime 3:DICH WithRelTime	-	-	3:DICH WithRelTime	Object 4, default variation
Obj10DefVar	1:BO 2:BO Status	-	-	2:BO Status	Object 10, default variation
Obj20DefVar	1:BinCnt32 2:BinCnt16 5:BinCnt32WoutF 6:BinCnt16WoutF	-	-	5:BinCnt32WoutF	Object 20, default variation
Obj22DefVar	1:BinCnt32EvWoutT 2:BinCnt16EvWoutT 5:BinCnt32EvWithT 6:BinCnt16EvWithT	-	-	1:BinCnt32EvWoutT	Object 22, default variation
Obj30DefVar	1:AI32Int 2:AI16Int 3:AI32IntWithoutF 4:AI16IntWithoutF 5:AI32FitWithF 6:AI64FitWithF	-	-	3:AI32IntWithoutF	Object 30, default variation
Obj32DefVar	1:AI32IntEvWoutF 2:AI16IntEvWoutF 3:AI32IntEvWithFT 4:AI16IntEvWithFT 5:AI32FitEvWithF 6:AI64FitEvWithF 7:AI32FitEvWithFT 8:AI64FitEvWithFT	-	-	1:AI32IntEvWoutF	Object 32, default variation

**Table 33:** *MST4TCP Non group settings (advanced)*

Name	Values (Range)	Unit	Step	Default	Description
AddrQueryEnbl	No Yes	-	-	Yes	Address query enable
tAppConfTOut	0.00 - 300.00	s	0.01	10.00	Application layer confirm timeout
AppMultFrgRes	No Yes	-	-	Yes	Enable application for multiple fragment response

Table continues on next page

## Section 4 DNP3 parameters

Name	Values (Range)	Unit	Step	Default	Description
ConfMultFrag	No Yes	-	-	Yes	Confirm each multiple fragment
UREnable	No Yes	-	-	Yes	Unsolicited response enabled
UREvClassMask	Off Class 1 Class 2 Class 1 and 2 Class 3 Class 1 and 3 Class 2 and 3 Class 1, 2 and 3	-	-	Off	Unsolicited response, event class mask
UROfflineRetry	0 - 10	-	1	5	Unsolicited response retries before off-line retry mode
tURRetryDelay	0.00 - 60.00	s	0.01	5.00	Unsolicited response retry delay in s
tUROfflRtryDel	0.00 - 60.00	s	0.01	30.00	Unsolicited response off-line retry delay in s
UREvCntThold1	1 - 100	-	1	5	Unsolicited response class 1 event count report treshold
tUREvBufTout1	0.00 - 60.00	s	0.01	5.00	Unsolicited response class 1 event buffer timeout
UREvCntThold2	1 - 100	-	1	5	Unsolicited response class 2 event count report treshold
tUREvBufTout2	0.00 - 60.00	s	0.01	5.00	Unsolicited response class 2 event buffer timeout
UREvCntThold3	1 - 100	-	1	5	Unsolicited response class 3 event count report treshold
tUREvBufTout3	0.00 - 60.00	s	0.01	5.00	Unsolicited response class 3 event buffer timeout
DelOldBufFull	No Yes	-	-	No	Delete oldest event when buffer is full
ExtTimeFormat	LocalTime UTC	-	-	UTC	External time format
DNPToSetTime	No Yes	-	-	No	Allow DNP to set time in IED
tSynchTimeout	30 - 3600	s	1	1800	Time synch timeout before error status is generated
TSyncReqAfTout	No Yes	-	-	No	Time synchronization request after timeout
Averag3TimeReq	No Yes	-	-	No	Use average of 3 time requests
PairedPoint	No Yes	-	-	Yes	Enable paired point
tSelectTimeout	1.0 - 60.0	s	0.1	30.0	Select timeout
tBrokenConTout	0 - 3600	s	1	0	Broken connection timeout
tKeepAliveT	0 - 3600	s	1	10	Keep-Alive timer

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## Section 5      Glossary

<b>AC</b>	Alternating current
<b>ACT</b>	Application configuration tool within PCM600
<b>A/D converter</b>	Analog-to-digital converter
<b>ADBS</b>	Amplitude deadband supervision
<b>AI</b>	Analog input
<b>ANSI</b>	American National Standards Institute
<b>AR</b>	Autoreclosing
<b>ASCT</b>	Auxiliary summation current transformer
<b>ASD</b>	Adaptive signal detection
<b>AWG</b>	American Wire Gauge standard
<b>BI</b>	Binary input
<b>BOS</b>	Binary outputs status
<b>BR</b>	External bistable relay
<b>BS</b>	British Standards
<b>CAN</b>	Controller Area Network. ISO standard (ISO 11898) for serial communication
<b>CB</b>	Circuit breaker
<b>CCITT</b>	Consultative Committee for International Telegraph and Telephony. A United Nations-sponsored standards body within the International Telecommunications Union.
<b>CCVT</b>	Capacitive Coupled Voltage Transformer
<b>Class C</b>	Protection Current Transformer class as per IEEE/ ANSI
<b>CMPPS</b>	Combined megapulses per second
<b>CMT</b>	Communication Management tool in PCM600
<b>CO cycle</b>	Close-open cycle
<b>Codirectional</b>	Way of transmitting G.703 over a balanced line. Involves two twisted pairs making it possible to transmit information in both directions
<b>COMTRADE</b>	Standard format according to IEC 60255-24
<b>Contra-directional</b>	Way of transmitting G.703 over a balanced line. Involves four twisted pairs, two of which are used for transmitting data in both directions and two for transmitting clock signals

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<b>CPU</b>	Central processor unit
<b>CR</b>	Carrier receive
<b>CRC</b>	Cyclic redundancy check
<b>CROB</b>	Control relay output block
<b>CS</b>	Carrier send
<b>CT</b>	Current transformer
<b>CVT</b>	Capacitive voltage transformer
<b>DAR</b>	Delayed autoreclosing
<b>DARPA</b>	Defense Advanced Research Projects Agency (The US developer of the TCP/IP protocol etc.)
<b>DBDL</b>	Dead bus dead line
<b>DBLL</b>	Dead bus live line
<b>DC</b>	Direct current
<b>DFC</b>	Data flow control
<b>DFT</b>	Discrete Fourier transform
<b>DHCP</b>	Dynamic Host Configuration Protocol
<b>DIP-switch</b>	Small switch mounted on a printed circuit board
<b>DI</b>	Digital input
<b>DLLB</b>	Dead line live bus
<b>DNP</b>	Distributed Network Protocol as per IEEE/ANSI Std. 1379-2000
<b>DR</b>	Disturbance recorder
<b>DRAM</b>	Dynamic random access memory
<b>DRH</b>	Disturbance report handler
<b>DSP</b>	Digital signal processor
<b>DTT</b>	Direct transfer trip scheme
<b>EHV network</b>	Extra high voltage network
<b>EIA</b>	Electronic Industries Association
<b>EMC</b>	Electromagnetic compatibility
<b>EMF</b>	(Electric Motive Force)
<b>EMI</b>	Electromagnetic interference
<b>EnFP</b>	End fault protection
<b>EPA</b>	Enhanced performance architecture
<b>ESD</b>	Electrostatic discharge
<b>FCB</b>	Flow control bit; Frame count bit

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<b>FOX 20</b>	Modular 20 channel telecommunication system for speech, data and protection signals
<b>FOX 512/515</b>	Access multiplexer
<b>FOX 6Plus</b>	Compact time-division multiplexer for the transmission of up to seven duplex channels of digital data over optical fibers
<b>G.703</b>	Electrical and functional description for digital lines used by local telephone companies. Can be transported over balanced and unbalanced lines
<b>GCM</b>	Communication interface module with carrier of GPS receiver module
<b>GDE</b>	Graphical display editor within PCM600
<b>GI</b>	General interrogation command
<b>GIS</b>	Gas-insulated switchgear
<b>GOOSE</b>	Generic object-oriented substation event
<b>GPS</b>	Global positioning system
<b>HDLC protocol</b>	High-level data link control, protocol based on the HDLC standard
<b>HFBR connector type</b>	Plastic fiber connector
<b>HMI</b>	Human-machine interface
<b>HSAR</b>	High speed autoreclosing
<b>HV</b>	High-voltage
<b>HVDC</b>	High-voltage direct current
<b>IDBS</b>	Integrating deadband supervision
<b>IEC</b>	International Electrical Committee
<b>IEC 60044-6</b>	IEC Standard, Instrument transformers – Part 6: Requirements for protective current transformers for transient performance
<b>IEC 61850</b>	Substation automation communication standard
<b>IEC 61850-8-1</b>	Communication protocol standard
<b>IEEE</b>	Institute of Electrical and Electronics Engineers
<b>IEEE 802.12</b>	A network technology standard that provides 100 Mbits/s on twisted-pair or optical fiber cable
<b>IEEE P1386.1</b>	PCI Mezzanine Card (PMC) standard for local bus modules. References the CMC (IEEE P1386, also known as Common Mezzanine Card) standard for the mechanics and the PCI specifications from the PCI SIG (Special Interest Group) for the electrical EMF (Electromotive force).

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<b>IEEE 1686</b>	Standard for Substation Intelligent Electronic Devices (IEDs) Cyber Security Capabilities
<b>IED</b>	Intelligent electronic device
<b>I-GIS</b>	Intelligent gas-insulated switchgear
<b>Instance</b>	When several occurrences of the same function are available in the IED, they are referred to as instances of that function. One instance of a function is identical to another of the same kind but has a different number in the IED user interfaces. The word "instance" is sometimes defined as an item of information that is representative of a type. In the same way an instance of a function in the IED is representative of a type of function.
<b>IP</b>	<p>1. Internet protocol. The network layer for the TCP/IP protocol suite widely used on Ethernet networks. IP is a connectionless, best-effort packet-switching protocol. It provides packet routing, fragmentation and reassembly through the data link layer.</p> <p>2. Ingression protection, according to IEC standard</p>
<b>IP 20</b>	Ingression protection, according to IEC standard, level 20
<b>IP 40</b>	Ingression protection, according to IEC standard, level 40
<b>IP 54</b>	Ingression protection, according to IEC standard, level 54
<b>IRF</b>	Internal failure signal
<b>IRIG-B:</b>	InterRange Instrumentation Group Time code format B, standard 200
<b>ITU</b>	International Telecommunications Union
<b>LAN</b>	Local area network
<b>LIB 520</b>	High-voltage software module
<b>LCD</b>	Liquid crystal display
<b>LDD</b>	Local detection device
<b>LED</b>	Light-emitting diode
<b>MCB</b>	Miniature circuit breaker
<b>MCM</b>	Mezzanine carrier module
<b>MVB</b>	Multifunction vehicle bus. Standardized serial bus originally developed for use in trains.
<b>NCC</b>	National Control Centre
<b>OCO cycle</b>	Open-close-open cycle
<b>OCP</b>	Overcurrent protection
<b>OLTC</b>	On-load tap changer
<b>OV</b>	Over-voltage

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<b>Overreach</b>	A term used to describe how the relay behaves during a fault condition. For example, a distance relay is overreaching when the impedance presented to it is smaller than the apparent impedance to the fault applied to the balance point, that is, the set reach. The relay “sees” the fault but perhaps it should not have seen it.
<b>PCI</b>	Peripheral component interconnect, a local data bus
<b>PCM</b>	Pulse code modulation
<b>PCM600</b>	Protection and control IED manager
<b>PC-MIP</b>	Mezzanine card standard
<b>PMC</b>	PCI Mezzanine card
<b>POR</b>	Permissive overreach
<b>POTT</b>	Permissive overreach transfer trip
<b>Process bus</b>	Bus or LAN used at the process level, that is, in near proximity to the measured and/or controlled components
<b>PSM</b>	Power supply module
<b>PST</b>	Parameter setting tool within PCM600
<b>PT ratio</b>	Potential transformer or voltage transformer ratio
<b>PUTT</b>	Permissive underreach transfer trip
<b>RASC</b>	Synchrocheck relay, COMBIFLEX
<b>RCA</b>	Relay characteristic angle
<b>RFPP</b>	Resistance for phase-to-phase faults
<b>RFPE</b>	Resistance for phase-to-earth faults
<b>RISC</b>	Reduced instruction set computer
<b>RMS value</b>	Root mean square value
<b>RS422</b>	A balanced serial interface for the transmission of digital data in point-to-point connections
<b>RS485</b>	Serial link according to EIA standard RS485
<b>RTC</b>	Real-time clock
<b>RTU</b>	Remote terminal unit
<b>SA</b>	Substation Automation
<b>SBO</b>	Select-before-operate
<b>SC</b>	Switch or push button to close
<b>SCS</b>	Station control system
<b>SCADA</b>	Supervision, control and data acquisition
<b>SCT</b>	System configuration tool according to standard IEC 61850

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<b>SDU</b>	Service data unit
<b>SMA connector</b>	Subminiature version A, A threaded connector with constant impedance.
<b>SMT</b>	Signal matrix tool within PCM600
<b>SMS</b>	Station monitoring system
<b>SNTP</b>	Simple network time protocol – is used to synchronize computer clocks on local area networks. This reduces the requirement to have accurate hardware clocks in every embedded system in a network. Each embedded node can instead synchronize with a remote clock, providing the required accuracy.
<b>SRY</b>	Switch for CB ready condition
<b>ST</b>	Switch or push button to trip
<b>Starpoint</b>	Neutral point of transformer or generator
<b>SVC</b>	Static VAr compensation
<b>TC</b>	Trip coil
<b>TCS</b>	Trip circuit supervision
<b>TCP</b>	Transmission control protocol. The most common transport layer protocol used on Ethernet and the Internet.
<b>TCP/IP</b>	Transmission control protocol over Internet Protocol. The de facto standard Ethernet protocols incorporated into 4.2BSD Unix. TCP/IP was developed by DARPA for Internet working and encompasses both network layer and transport layer protocols. While TCP and IP specify two protocols at specific protocol layers, TCP/IP is often used to refer to the entire US Department of Defense protocol suite based upon these, including Telnet, FTP, UDP and RDP.
<b>TNC connector</b>	Threaded Neill-Concelman, a threaded constant impedance version of a BNC connector
<b>TPZ, TPY, TPX, TPS</b>	Current transformer class according to IEC
<b>UMT</b>	User management tool
<b>Underreach</b>	A term used to describe how the relay behaves during a fault condition. For example, a distance relay is underreaching when the impedance presented to it is greater than the apparent impedance to the fault applied to the balance point, that is, the set reach. The relay does not “see” the fault but perhaps it should have seen it. See also Overreach.
<b>UTC</b>	Coordinated Universal Time. A coordinated time scale, maintained by the Bureau International des Poids et Mesures (BIPM), which forms the basis of a coordinated dissemination of standard frequencies and time signals. UTC

is derived from International Atomic Time (TAI) by the addition of a whole number of "leap seconds" to synchronize it with Universal Time 1 (UT1), thus allowing for the eccentricity of the Earth's orbit, the rotational axis tilt (23.5 degrees), but still showing the Earth's irregular rotation, on which UT1 is based. The Coordinated Universal Time is expressed using a 24-hour clock, and uses the Gregorian calendar. It is used for aeroplane and ship navigation, where it is also sometimes known by the military name, "Zulu time." "Zulu" in the phonetic alphabet stands for "Z", which stands for longitude zero.

<b>UV</b>	Undervoltage
<b>WEI</b>	Weak end infeed logic
<b>VT</b>	Voltage transformer
<b>X.21</b>	A digital signalling interface primarily used for telecom equipment
<b>3I<sub>O</sub></b>	Three times zero-sequence current. Often referred to as the residual or the earth-fault current
<b>3U<sub>O</sub></b>	Three times the zero sequence voltage. Often referred to as the residual voltage or the neutral point voltage





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